AMENDMENTS TO THE SPECIFICATION:

Please replace the paragraph beginning at page 10, line 5, and ending at page 10, line 6, with the following paragraph. The amendments to this paragraph are indicated by strikethrough and underlining.

Figure 1 illustrates a ~~cross-sectional~~ view of a confocal microscope system according to a preferred embodiment;

Please replace the paragraph beginning at page 10, line 12, and ending at page 10, line 13, with the following paragraph. The amendments to this paragraph are indicated by strikethrough and underlining.

Figures 5A-5C illustrate, respectively, ~~plan~~sectioned, ~~end and side~~side and end views of a ferrule and associated components;

Please replace the paragraph beginning at page 12, line 9, and ending at page 12, line 25, with the following paragraph. The amendments to this paragraph are indicated by strikethrough and underlining.

In the first preferred embodiment of Figure 2, the rnicroprobe 40 is configured for frontal imaging ("end-face viewing") with a housing that has an outer diameter of about 1.5 millimeters and whose length is about 10 millimeters along the longitudinal axis A-A. In the second preferred embodiment of Figure 3, the microprobe 40 is configured for side imaging by virtue of a reflector 53 with a housing that has an outer diameter of about 1.8 millimeters and whose length is about 10 millimeters along the longitudinal axis A-A. As configured in

the preferred embodiments, light 60 is transmitted by the optical fiber 44 to an aperture 56 ~~(e.g., pin-hole)~~ so that a light beam 60a is directed to retro-reflecting mirror 52e. Retro-reflecting mirror 52e reflects some portion or all of light beam 60a as a redirected beam 60b to the scanning mirror assembly 48. The scanning mirror assembly 48 reflects some or all of the redirected beam 60b as objective light beam 60c through the objective lens to converge on a focal point F1. And although the length has been described as preferably 10 millimeters, other suitable lengths can be utilized such as, for example, by reducing the length of the microprobe 40 via a reduction in the number of objective lenses while maintaining the necessary parameters for its operation.

Please replace the paragraph beginning at page 13, line 18, and ending at page 14, line 2, with the following paragraph. The amendments to this paragraph are indicated by strikethrough and underlining.

As shown in an exploded view of Figure 4A, ferrule 46 has first ferrule end 46a and second ferrule end 46b extending along longitudinal axis A-A. In a close-up view of the ferrule 46 in Figure 4B, the ferrule 46 preferably has a polygonal cross-section 46c with a planar portion 46d extending orthogonal to the cross-section 46c along the longitudinal axis A-A to provide a mounting surface for control circuits or communication wires 54 for actuators 46e-46h and ~~actuators~~<u>mirror portions</u> 48c and [[48g]]<u>48d</u> and ground connection for scan mirror elements 48e and [[48i]]<u>48f</u>. One or more boss portions 46j, 46k can be formed on the surface 46c so as to provide a gap 46i between the scanning mirror assembly 48 and the actuators 46e-46h. The ferrule 46 can be formed unitarily or joined together by a

suitable non-conductive or semi-conductive material that has sufficient stiffness, such as, for example, non-metals, silicon, ceramic, glass or various combinations of these materials. Preferably, the ferrule 46 is a combination of ceramic and glass.

Please replace the paragraph beginning at page 14, line 17, and ending at page 15, line 12, with the following paragraph. The amendments to this paragraph are indicated by strikethrough and underlining.

As shown in Figures 5A and 5B, the ferrule 46 includes first ferrule end 46a and second ferrule end 46b~~ connected by ferrule wall 46c. The ferrule wall 46c has wall surface 47 that forms an aperture 56 extending through the ferrule 46 along the Z-axis. The aperture 56 can be a generally cylindrical through-hole of a diameter typically ranging from 10 microns to 125 microns, and preferably 75 microns~~. The first ferrule end 46a of the ferrule 46 can include a circuit board 58 that controls or interfaces with various components of the probe 40 and the electrical interface 24. Electrical connections can be formed on the planar surface 46d of the ferrule 46 (which forms a D-shaped cross-section) by a suitable technique, such as, for example, etching or vapor depositions. The second ferrule end 46b can be a generally planar end face 46c with a mirror 48a mounted on the end face 46c with a suitable technique, such as, for example, bonding or gluing. And although an optical fiber 44 is shown in the preferred embodiments that transmits and receives light, a laser source can be located in the aperture 56 instead of the optical fiber 44. Alternatively, a combination of a laser source and a suitable photodetector can be located in the aperture 56 proximate to the second ferrule end and distal to the first ferrule end. As used herein, the term "photodetector"

means a suitable light detection device such as, for example, a photomultiplier or photodiodes (e.g., silicon photodiodes). While the "light source" is preferably a laser source, other light sources of sufficient power density may be appropriate in some applications. Moreover, the light source can include, but is not limited to, ~~to~~ light in the visible or non-visible light (e.g., to the human-eye) such as, for example, 200 nanometers to about 3 microns. And the light (e.g., visible or invisible to the human eye) is not limited to a specific wavelength and can be a combination of various wavelengths.

Please replace the paragraph beginning at page 15, line 13, and ending at page 16, line 2, with the following paragraph. The amendments to this paragraph are indicated by strikethrough and underlining.

As shown in ~~Figures 6C~~Figure ~~and~~ 7A, the scanning mirror assembly 48 preferably has a support surface 48b on which scanning mirror 48a is supported. The scanning mirror 48a can be formed to provide two mirror portions 48c and 48d in a generally concentric arrangement. Both mirror portions 48c and 48d are supported by a gimbaled plate member 48e. Mirror 48a and gimbaled plate member 48e ~~rotates~~rotate via a first set of diametrically disposed beam members 49 about the X-X axis, i.e., a tipping axis relative to the support surface of the scanning mirror assembly 48. The gimbaled ~~plate~~ring member 48[[e]]f is supported by a second set of diametrically disposed beam members 49 (Fig. 6B) and rotates about the Y-Y axis, i.e., a tilting axis relative to the support surface of the scanning mirror assembly 48. As shown in Figure 7B, the mirror 48a is shown as rotating about the tipping axis X-X so that the axis Z of the mirror 48a is tilted over an included angle θ relative to the longitudinal axis A-A. Similarly, the mirror 48a can also rotate about the tilting axis Y-Y based on the gimbaled arrangement (not shown in

Figure 7B for clarity). By virtue of this arrangement, the mirror 48a can rotate in two axes to move a focal point F1 to F2 of a light beam in two axes and provide for two-dimensional scanning (Figs. 2 and 3) of the focal point of the light beam through the at least one objective lens 52. Preferably, the outer diameter of the scanning mirror ~~assembly~~48a is about 700 microns.

Please replace the paragraph beginning at page 17, line 15, and ending at page 18, line 27, with the following paragraph. The amendments to this paragraph are indicated by strikethrough and underlining.

At least one actuator can be used to move the scanning mirror 48a about the axes and to deform the membrane 48h. Preferably, conductive surfaces 46e-46h can be provided on the planar surface of the ferrule 46 so that energization of the conductive surfaces 46e-46h causes the scanning mirror 48a to move. In this embodiment the ~~mirror 48a and gimbal ring 48e~~gimbaled plate member 48e and gimbaled ring member 48f form the counter electrode for electrostatic actuation. Movements of the scanning mirror 48a can be by thermoelectrical, electrostatic, or other suitable actuation techniques. ~~In thermo-electrical actuation, heat can be generated by applying electrical current via the conductive surfaces 46e-46h to a resistive portion of the mirror 48a. This portion can have two different materials to provide for differential expansion and therefore movements of the mirror 48a.~~ In electrostatic actuation, the mirror 48a can be connected to a ground state and separated from the conductive surfaces 46e-46h by a gap so that when a voltage is applied, the mirror 48a is attracted to the conductive surfaces 46e-46h, i.e., electrodes to provide for movements of the mirror 48a. In both arrangements, control of the movements of the mirror 48a can be obtained by open loop or closed-loop control. In open-loop control, it is assumed that the kinematic response by the scanning mirror 48a is within predictive

parameters so that establishing the drive voltage defines the mirror position with sufficient accuracy for the application. In closed-loop control, the position of the scanning mirror 48a is independently monitored and this information is used as a feedback (e.g., proportional, integral, derivative or combinations thereof) signal that attempts to lock the motion of the scanning mirror 48a to the drive voltage waveform. One technique to monitor the position of the mirror 48a is to measure the capacitance between the scanning mirror 48a and the electrodes. This capacitance will vary with the angular position of the mirror 48a so that monitoring the capacitance fluctuation provides a generally direct monitoring of the mirror position. Another technique is to measure the strain on each of the beam members 49 with a suitable piezoelecbic element micro-machined onto or into the beam members 49. A variety of other approaches are available to determine the mirror position, including optically monitoring the beam or intermittent monitoring of the position or amplitude. With a suitable controller for closed loop control, the control loop is capable of causing the mirror to virtually follow the drive voltage directly so that the controller is able to map the intensity of the drive voltage to the proper position of the scanning rnirror 48a, without requiring the prediction of the mirror kinematics. Preferably, the actuation of the scanning mirror 48a for two-dimensional scanning is by electrostatic actuation via resonant (e.g., 1 kilo-Hertz or a suitable frequency) open loop control of at least one of the first or gimbaled members 48e or 48f, with damping provided by the air mass in the volume 46i between the scanning mirror 48a and the conductive surfaces 46e-46h (Fig. [[6B]]<u>6C</u>). In the preferred embodiments, the actuators provide for about ±5° of rotation of the mirror about each of the X and Y-axes.

Please replace the paragraph beginning at page 20, line 8, and ending at page 20, line 11, with the following paragraph. The amendments to this paragraph are indicated by strikethrough and underlining.

In a preferred embodiment, the maximum displacement δ of the deformable reflective membrane 48h is about 5 microns such that the range dF of focus adjustment is about 125 microns.~~ Preferably, the focal length is about 6.1 or 12 millimeters to infinity.~~

Please replace the paragraph beginning at page 20, line 12, and ending at page 22, line 11, with the following paragraph. The amendments to this paragraph are indicated by strikethrough and underlining.

The scanning mirror assembly 48 can be formed by micro-machining of a substrate, such as, for example, silicon.[[.]] A thermal oxide layer can be disposed on the substrate. A sacrificial phosphosilicate glass layer is also provided over the thermal oxide and patterned to define the lateral extent of the air gap G. A silicon nitride layer can be formed on the phosphosilicate glass layer and thermal oxide layer. Contact openings can be patterned and etched through the silicon nitride and the underlying oxide, which can be followed by a phosphorus implant and anneal to establish electrical contact to the silicon substrate material in the region of the ~~mirror 48a, gimbal ring 48e and support ring 48b~~<u>gimbaled plate member 48e and gimbaled ring member 48f</u>. This electrical contact allows the silicon substrate material in the region of the ~~mirror 48a and gimbal ring 48e~~<u>gimbaled plate member 48e and gimbaled ring member 48f</u> to serve as a counter electrode for electrostatic actuation. A conducting layer can also be formed on the nitride layer and patterned to provide for a conductive and reflective surface 48h<u> (comprising mirror portions 48c and 48d)</u> and specifically actuators A1 and A2, and to provide electrical connection to

implant regions in the contact openings, and also provide traces for external connection to these various conducting structures. This conducting layer is preferably gold over a thin chromium layer. The mirror outlines and other structures can also be patterned and etched into the silicon nitride layer followed by an anisotropic silicon etch to define the mirror and gimbal ring structures. This anisotropic etch using a technique such as deep reactive ion etching may penetrate through the entire substrate. Alternatively this etch may penetrate a certain depth into the substrate, and a separate thinning etch may be applied to the back of the substrate to remove the bulk substrate material until the desired substrate thickness is achieved and the front side anisotropic etched features are then penetrating through the full thickness of the mirror plate 48a and gimbal ring 48[[e]]f. A sacrificial oxide etching process is preferably provided to remove the glass layer. Preferably, the etching process utilizes an acid etching process such as, for example, hydro-fluoric acid. This etch removes the phosphosilicate glass (if such a layer is present) and also removes the thermal silicon dioxide under the nitride layer forming the membrane 48h. A subsequent anisotropic etching process, which can be a wet type such as potassium hydroxide or tetramethylammonium hydroxide, is preferably provided to remove some of the substrate layer to provide for the gap G between the deformable reflective membrane 48h and its substrate, and also will remove the substrate material from beneath the silicon nitride hinges 49. Alternatively, an isotropic wet etching process such as, for example, hydrofluoric, nitric and acetic acids (HNA) may be used to provide for the gap G and to remove the substrate material from beneath the hinges 49. Alternatively an isotropic dry etching process such as, for example, xenon difluoride vapor may be used to provide for the gap G and to remove the substrate material from beneath the hinges 49. Specific details of the unitary scanning mirror assembly, techniques for manufacturing and controlling the unitary scanning mirror are shown and described in *Yuhe Shao*

and David L. Dickensheets, "MEMS Three-Dimensional Scan Mirror," SPIE Vol. 5348, pp. 175-183, January 26-27, 2004, which is incorporated by reference in its entirety into this application. Details for the fabrication of similar micro-machined mirrors are shown and described in International Patent Application No. PCT/US02/33351 (published as International Publication Number WO 03/036737A2 on 01 May 2003) filed in the United States Patent and Trademark Receiving Office on 21 October 2002, which application is incorporated by reference into this application in its entirety herein. The general details for fabricating micro-machined deformable mirrors are well known to those skilled in the art. *See*, for example, U.S. Pat. Nos. 6,661,561; 6,656,768; 6,507,082; 6,398,372; 6,293,680; 6,236,490; 6,181,459; 6,108,121; 6,002,661; 5,986,795; 5,777,807; 5,661,592; 5,311,360; and *David L. Dickensheets*, "Silicon-Micromachined Scanning Confocal Optical Microscope," Journal of Microelectromechanical Systems, Vol. 7, No. 1, March 1998, all of which are herein incorporated by reference in their entirety.

Please replace the paragraph beginning at page 23, line 20, and ending at page 23, line 24, with the following paragraph. The amendments to this paragraph are indicated by strikethrough and underlining.

Referring to Figure 1, the moving of the scanning mirror 48a and the deforming of the reflective surface 48h[[s]] are preferably provided by the electronic interface 24 connected to the microprobe 40 by a multi-strand cable [[54]]<u>55</u>. The multi-strand cable [[54]]<u>55</u> is connected to the respective actuators 46e-46h, Al, and A2, and the substrate of the scanning mirror assembly 48.

Please replace the paragraph beginning at page 23, line 25, and ending at page 25, line 2, with the following paragraph. The amendments to this paragraph are indicated by strikethrough and underlining.

Referring to Figure 8A, a preferred embodiment of the at least one objective lens 52 is shown. The at least one objective lens 52 can be a group of lenses that preferably is water ~~immersable~~immersible and when assembled with the microprobe [[20]]40, provides for four times the magnification of an object over a field of view of about 200 microns with a focal length of about 1 millimeter in air, a numerical aperture of about 0.4 for wavelength in the range of 400-600 nanometers. The group of lenses includes at least one diffractive optical element with at least one refractive optical element to provide for achromatization (e.g., correction of chromatic and spherical aberrations) of light through the at least one objective lens 52. Preferably, the group of lenses includes a diffractive optical element 52a made of pure silica glass and three refractive optical elements 52b, 52c, 52d made of BK7 (e.g., borosilicate crown) glass. The refractive optical elements 52b-52d preferably are plano-convex lenses, which are in contact with one another on the respective end faces of the lenses. The diffractive optical element 52a can also be assembled so as to contact one of the refractive optical elements 52b-52d so that the total length of the group of objective lenses is about 5 millimeters. Where a shorter length of the objective lens 52 (and therefore the length of the housing 42) is desired, a higher index of refraction glass material such as, for example, diamond or sapphire, can be used. Alternatively, the objective lens 52 can be a single element lens or the lens 52 can be formed unitarily as a monolithic structure with the housing 42. In the preferred embodiments, the group of objective lenses 52a-52d are fixed to an inner wall of the housing 42, where the housing has a maximum cross-section area

generally transverse to the longitudinal axis A-A of less than about 9 millimeter-squared. In another preferred embodiment, the group of objective lenses 52a-52d is fixed to the inner wall of the housing 42, where the housing has a maximum outside diameter of 1.5 millimeters. It is noted that the lenses are preferably circular in cross-section. And the preferred embodiment of the objective lenses, where the diameter of the lenses is taken to be 1.6 mm, is shown to relative scale in Figure 8A such that, when appropriately scaled for the preferred embodiments, the objective lenses would operate, in conjunction with other components, to permit confocal imaging of objects. One skilled in the art can also determine the appropriate lens configuration based on selected parameters shown and described herein using conventional and commercially available optical design software.

Please replace the paragraph beginning at page 25, line 9, and ending at page 25, line 15, with the following paragraph. The amendments to this paragraph are indicated by strikethrough and underlining.

Referring to Figure 8C, an illustration of the resolution of the objective lens 52 is shown for two data[[;]], one on-axis and one off-axis. As shown in the plot line 104, the width of the point spread function on-axis at half-maximum of the confocal response (width at .707 maximum of the plotted "one-way" point spread function) of the main lobe is believed to be acceptable at about 0.52 micron[[s]]. As shown in the plot line 106, the width at half-maximum of the confocal response point spread function at about 100 microns off-axis is about .7 micron[[s]].

Please replace the paragraph beginning at page 26, line 3, and ending at page 27, line 7, with the following paragraph. The amendments to this paragraph are indicated by strikethrough and underlining.

Based on the preferred embodiments described above, a method of controlling the focusing spot F1 of the probe 40 or to scan an object can be achieved. The method involves focusing control of the objective beam 60c or scanning control of the objective beam 60c at discrete intervals, overlapping intervals, or simultaneous time intervals. Specifically, focusing control can be performed via deformations of the reflective membrane 48h using differential electrostatic voltages supplied to the respective electrodes A1 and A2 so that the focusing spot F1 is translated along focal axis Z defined by the light beam to a different spot, such as, for example, F3. While focusing control is being performed on the objective beam, scanning control can also be performed by tilting the base 48i of the scanning mirror 48a about the respective orthogonal axes X-X and Y-Y so that the focusing spot F1 can translate laterally with respect to the focal axis Z to focusing spot F2. More particularly, the confocal microprobe 40 can scan in all three dimensions at a scan rate sufficient to view an object, such as for example, 24,36, or 42 frames of the image of the object per second. Preferably, the confocal microprobe 40 can translate the focal point laterally along the X-Y plane with respect to the focal axis at a scanning rate of at least 1 [[kilo-]]<u>k</u>Hertz, so that the scan rate is sufficient to produce at least 200 lines in a frame not exceeding [[20]]<u>200</u> milliseconds. That is, the scanning mirror and objective lens can translate the focal point along a focal axis to scan an object at a scan rate of [[20]]<u>1</u> [[kilo-]]<u>k</u>Hertz. Other scan rates for both lateral and axial scanning are possible, including axial rates (focus adjustment) in excess of 100 kHz. Where the environment or object to be scanned is generally static over time, the scan rate can be arbitrarily selected to provide a sufficiently useful

image. Also preferably, the deformable membrane 48h and actuators A1 and A2 (of the scanning mirror assembly 48) provide means for moving the light beam at a plurality of focal positions on a focal axis Z defined by the light beam. In particular, the scanning mirror assembly 48 with a non deformable mirror (e.g., one whose surface is not selectively deformable to change its planar or curved surface) provides the means for scanning a light beam across a plane generally orthogonal to the focal axis Z. More preferably, the scanning mirror assembly 48 and the objective lens 52 provide the means for moving the light beam at a plurality of focal positions axially and laterally with respect to a focal axis Z defined by the light beam over a distance of about 100 microns.